# A correlation-based inversion approach for aerosol remote sensing

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Aerosol properties such as size distribution, shape, composition and complex refractive index are directly retrieved in traditional optimization approach. It faces a number of confounding issues. Among the main challenges to overcome are non-uniqueness of the solutions and the large computational burden. To stabilize the inversion process, optimization-based inversions are often informed by extra constraints that supplement the observations. A particularly effective constraint applied to remote sensing inversion is the so-called smoothness condition [1–3]. For example, imposition of smoothness constraints on the variations of aerosol loading and their optical and microphysical properties in the spatial and spectral dimensions leads to the formulation of multi-pixel inversion approach [4]. However, the dimensionality of the retrieval space is proportional to the number of inverted pixels and the number of vertical layers to resolve aerosol properties. This slows down the retrieval efficiency and increases ill-posedness. To mitigate these issues, we capitalize on the empirical dependencies between different sets of aerosol physical quantities and capture their correlation by use of principal components (PCs) which constitute a significantly reduced parameter space. We further developed a correlation-based aerosol inversion approach to retrieve PCs of correlated fields [5]. Capitalizing on the mutual orthogonality of PCs, we also developed a perturbation-based radiative transfer computation. It uses a few dominant PCs to capture the difference in the radiation fields across an imaged area and computes the radiation fields for multiple imaging pixels simultaneously. Our retrieval is tested using observations acquired by JPL's Airborne Multiangle SpectroPolarimetric Imager and validated using collocated AERONET observations.

## References

[1] Phillips, D. L., 1962: A technique for numerical solution of certain integral equation of first kind. *J. Assoc. Comp. Mach.* **9**, 84–97.
[2] Twomey, S., 1977: *Introduction to the Mathematics of Inversion in Remote Sensing and Indirect Measurements*. Elsevier, New York.
[3] Tikhonov, A. N., and V. Y. Arsenin, 1977: *Solution of Ill-Posed Problems.* Wiley, New York.
[4] Dubovik, O., M. Herman, A. Holdak, T. Lapyonok, et al., 2011: Statistically optimized inversion algorithm for enhanced retrieval of aerosol properties from spectral multi-angle polarimetric satellite observations. *Atmos. Meas. Tech.* **4**, 975–1018.
[5] Xu, F., D. J. Diner, O. Dubovik, and Y. Schechner, 2019: A correlated multi-pixel inversion approach for aerosol remote sensing. Remote Sens. **11**, 746.

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